

part of the island above the surface of the water is mostly formed.

"Towards evening we lay to at the Nikandrow Islands in the neighbourhood of a fishing-station still inhabited. Jenisei is renowned for its richness in large eatable fish-species. . . . I hope some months after our return home to be able to exhibit to those among us who are interested in fishing, specimens of most of the varieties of fish occurring here. During our sailing up the river between Dudinka and Jeniseisk, I caused specimens of all the species of fish which we could procure from the river to be carefully deposited in a cask filled with spirit. This collection will be sent to Stockholm *via* St. Petersburg, by a merchant settled in Jeniseisk.

"Like most of the settlers on the lower course of the Jenisei, the inhabitants at Nikandrow fishing-station kept a number of dogs which are believed to be of the same race as the dogs used on Greenland, for draught. The dogs are employed in summer to tow boats up the river, and in winter for all sorts of carriages. Yet the dog, for reasons stated in the introduction to Middendorff's 'Sibirische Reise,' is considered quite unfit for long journeys over uninhabited tracts, if several hunting or fishing stations are not to be met with in the course of the journey. In such cases reindeer are always employed.

"Early next day we sailed, or more correctly, rowed on, the weather being calm and beautiful. We rested at midday in the neighbourhood of a now deserted *simovie* on the southern part of Sopotschnoi Island. Hence we continued our journey first to Cape Maksuninskoi, where we visited a Samoyede family that had set up their skin tent here in order to collect the necessary stock of fish for winter; afterwards to Tolstoj Nos, a still inhabited, well-built *simovie*, where the people living there received us in a very friendly way, and received the account of our journey with great interest and astonishment."

From here the party made haste to catch the last steamer at Saostrowoskoj, in the neighbourhood of Dudinka, which they did on Aug. 31.

"We were yet far north of the Arctic circle, and as many imagine that the region we had now passed through, the so little-known tundra of Siberia, is a desert waste, either covered by ice and snow or by an exceedingly scanty moss vegetation, it is perhaps the place here to declare that this by no means is the case. On the contrary, we saw, during our passage up the Jenisei, snow only at one place, a deep valley cleft of some fathoms' extent, and the vegetation, especially on the islands which are overflowed during the spring floods, was remarkable for a luxuriance to which I had seldom before seen anything corresponding.

"The fertility of the soil and the immeasurable extent of the meadow land and the richness of the grass upon it had already called forth from one of our hunters, a middle-aged man, who is owner of a little patch of ground between the fells in Northern Norway, a cry of envy of the splendid land our Lord had given 'the Russian,' and of astonishment that no creature pastured, no scythe mowed the grass. Daily and hourly we heard the same cry repeated, though in yet louder tones, when we some weeks after came to the lofty old forests between Jeniseisk and Turuchansk, or to the nearly uninhabited plains on the other side of Krasnojarsk, covered with deep *tschornosem* (black earth)—in fertility certainly comparable to the best parts of Scania, in extent exceeding the whole of the Scandinavian peninsula. This direct expression of opinion by a veritable if unlearned agriculturist may perhaps not be without its interest in judging of the future of Siberia.

"During this very summer three separate Russian expeditions have travelled through Siberia with the view of ascertaining the possibility of improving the river communication within the country. These expeditions have, according to unofficial communications made to me in Jeniseisk, come to the conclusion that it is possible for a sum of 700,000 roubles to make the Angara (a tributary of the Jenisei) navigable to Lake Baikal, and to connect the Obi with the Jenisei and the Jenisei with the Lena. How great an extent of territory the proposed river communication will embrace is best seen by considering that the territory drained by the Obi-Irtisch and the Jenisei alone is of greater extent, according to Von Baer's calculation, than the river areas of all the rivers (the Danube, Don, Dnieper, Dniester, Nile, Po, Ebro, Rhone, &c.), which fall into the Black Sea, the Sea of Marmora, and the Mediterranean. Part of this territory indeed lies north of the Arctic circle, but here too are found the most extensive and finest forests of the globe; south of the forest region proper there stretch out terri-

ories, several hundred leagues in extent, level, free of stones, covered with the most fertile soil, which only wait for the plough of the cultivator to yield the most abundant harvests; and farther to the south the Jenisei and its tributaries run through regions where the grape ripens on the bare ground: just now, as I write this, I have before me a bunch of the finest Siberian grapes. May the future show that sea communication between these lands and Europe has now been fairly inaugurated.

"A. E. NORDENSKJÖLD."

SCIENTIFIC SERIALS

Der Naturforscher, October 1875.—In this number is given an observation by M. Coulier, that while a cloud was formed in a vessel containing a little water, when an attached caoutchouc balloon was first compressed, then allowed to expand, no cloud was thus produced if the vessel had stood some time at rest, or if the air had been filtered; and the author's view was confirmed that small particles in the air were what caused the formation. M. Mascart has found that strongly ozonized air is not robbed of its cloud-forming action by filtering.—There are two valuable papers in meteorology, one by M. Hann, on the variability of daily temperature, and another in which M. Kerner offers an explanation of the fact that there is, in the Swiss valleys, in late autumn and winter, a middle warm region limited both below and above by a colder.—In physiology we note some interesting researches by M. Bernstein as to what is the highest pitch of tone a muscle may be made to give by electric stimulation. Above 418 vibrations per second of the spring contact, the muscle tone (the same as that of the spring) was distinct, though weaker; at 1,056 vibrations no distinct tone was observed, only a noise. But if the *nerve* were stimulated to the latter degree the muscle gave a tone, not indeed the same as the spring, but a fifth, sometimes an octave, lower. The upper limit beyond which the muscle ceased to give the same tone with the spring (in this arrangement) seemed to be about 933 vibrations. Under chemical stimulus of a nerve, the connected muscle gave a tone like that in natural contraction.—There is also a suggestive paper by M. Delbœuf on the theory of sensation, and M. Hirschberg describes observations on a boy who acquired sight at seven years of age; they favour, he considers, the empiricist theory of sight-perceptions.—In a paper on the origin of the deep-water fauna of the Lake of Geneva, M. Forel thinks the entire fauna of the Swiss lakes are descended from forms which have migrated (up the rivers) since the melting of the glaciers, and have afterwards been differentiated.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, Oct. 1.—Dr. Wild, Director of St. Petersburg Observatory, relates the circumstances which led to the Imperial assent being given in June last to the scheme for the establishment at Pawlowsk, distant about an hour by railway from St. Petersburg, of an observatory to be affiliated to the central institution for terrestrial physics over which he presides. The Central Observatory was built twenty-six years ago in an open and quiet space outside the capital. Houses and streets have, however, rapidly been constructed around it, masses of iron are in proximity, and noise and smoke disturb physical measurements, magnetic and meteorological observations. Herr Wild knew that there were serious objections to the removal of the whole establishment into the country, as has been done at Vienna, and determined to recommend a separation into two divisions, one observing and the other administrative, in imitation of the London Meteorological Office and Kew Observatory, the relations to the public of the Russian being similar to those of the English Meteorological Department. On his making this proposal at the Academy of Sciences last autumn, Prince Nicolajewitsch generously presented for the purposes of the new observatory a large piece of ground in his park at Pawlowsk. There will be no reduction in the estimate for the Central Observatory, in order that local observations may be continued, and the accumulated records of former years worked out.—Dr. Hellmann contributes a paper on the physical conditions of the higher atmospheric strata, in which he discusses the observations made in May 1872 by the U.S. War Department at the summit (1,915 metres high), and at the base of Mount Washington, New Hampshire. It appears among other results that the mean difference of temperature for 100 metres of ascent between the hours of 6 A.M. and 6 P.M. and 9 P.M. and 12 P.M. at night was '69° C., and that the difference between 4 and 5 P.M. was '83 and at 6 A.M. only '48° C.; that in 17·4 cases per cent. the wind at the top was the same in

direction as that below; and that the diminution of temperature with increasing height was greater in clear than in cloudy weather. This last result is in agreement with that of Herr Hann, derived from observations taken at Praya West and Victoria Peak.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Nov. 19.—“On some Elementary Principles in Animal Mechanics. No. VII. The Law of Fatigue.” By the Rev. Samuel Houghton, M.D. (Dubl.), D.C.L. (Oxon), F.R.S., Fellow of Trinity College, Dublin.

The approximate law of muscular action, which I have called the law of fatigue, is thus expressed:—“When the same muscle (or groups of muscles) is kept in constant action until fatigue sets in, the total work done multiplying by the rate of work done is constant.”

The following experiments, in illustration of this law, were performed in Trinity College during the spring of the present year.

I instructed a number of medical students, chosen at random, to raise dumbbells of varying weight, one in each hand, in the transverse plane, with hands supinated, raising and lowering the weights in equal times regulated by the beat of a pendulum. This process was continued until the distress of the fatigue produced became intolerable, and the number of times each weight was lifted was noted. The students were required to count “one-two,” in time to the beat of the pendulum, so as to prevent them from counting the total number of lifts of the weight. Prof. Macalister assisted me in these experiments; and one of us counted the number of lifts, while the other compelled the experimenters to observe the conditions of the experiment, which were:—

1. To keep time with the pendulum.
2. To raise the weight in the transverse plane.
3. To supinate the hands.
4. To abstain from all bending of the knees or spinal column.

For each experiment I chose twenty students at random, using altogether about fifty different students; and no individual was experimented upon again, until an interval of forty-eight hours had elapsed. The object of this arrangement was to avoid the effects of “training.” In my first Table I give the mean result of twenty different students; and in my second Table I have selected one student, set aside for the purpose, and experimented upon, once a week, so as to prevent the influence of “training.”

Let W denote the total work done, and T the time of doing it; then, by the law of fatigue,

$$\frac{W^2}{T} = \text{constant} \dots \dots \dots (1)$$

If w be the weight held in the hand, and a be half the weight of the arm, and n the number of times the weights are lifted; since the time of raising and lowering the arms is constant, n is proportional to T , and the law of fatigue gives the formula

$$(w + a)^2 n = A \dots \dots \dots (2)$$

where A is an unknown constant. In the following Table I give the values of w and the mean value of n for twenty distinct persons. The time of lift is in all cases one second.

TABLE I.—Mean of Twenty Experiments.

No.	w .	n (obs.)	n (calc.)	Diff.
	lbs.			
1.	2.56	131.80	128.0	+3.8
2.	4.25	87.55	78.3	+9.2
3.	5.87	47.35	53.5	-6.2
4.	6.87	40.25	43.7	-3.5
5.	7.75	34.60	37.1	-2.5
6.	9.75	27.15	26.8	+0.3
7.	14.00	17.20	15.4	+1.8

The column containing the calculated values of n was obtained from equation (2) by using the values

$$a = 3.50 \text{ lbs.}$$

$$A = 4699.$$

These values were obtained by finding the value of a , which renders A most nearly a constant, or

$$\frac{\delta A}{A} = \text{minimum.}$$

This Table gives 7 lbs. for the mean weight of the arm of all experimented on, a result which accords with the known facts.

In Table II. I give the results obtained from a single student, as already described, each value of n being a mean of several experiments, closely concurrent.

TABLE II.—Mr. Samuel Warren.

No.	w .	n (obs.)	n (calc.)	Diff.
	lbs.			
1.	2.56	140.0	137.5	+2.5
2.	4.25	91.0	86.4	+4.6
3.	5.87	63.0	60.1	+2.9
4.	6.87	43.0	49.0	-6.0
5.	7.75	40.0	42.5	-2.5
6.	9.75	32.0	31.0	+1.0
7.	14.00	18.5	17.9	+0.6

The calculated values of n were found from equation (2), using the values

$$a = 3.9 \text{ lbs.}$$

$$A = 5737,$$

which were obtained from the principle of least variation of A , or

$$\frac{\delta A}{A} = \text{minimum.}$$

In the accompanying diagrams I. and II., I have plotted the cubical hyperbola represented by equation (2); and also the several observations which lie sufficiently near the curve to justify me in considering the law of fatigue to be a first approximation to one of the fundamental laws of muscular action. I have elsewhere * shown that the law of fatigue corresponds with other experiments based on different data.

If we consider the *useful work* only, we have from equation (2),

$$\text{useful work} = wn = \frac{A w}{(w + a)^2} \dots \dots \dots (3)$$

This equation represents a cuspidal cubic, whose ordinate has a maximum value, when $w = a =$ half the weight of the arm.

The foregoing observations are in accordance with this deduction, as may be seen from Table III.

TABLE III.—Useful Work.

No.	w .	wn (20 experiments).	wn (Mr. Warren).
	lbs.		
1.	2.56	338	358
2.	4.25	372	387
3.	5.87	277	370
4.	6.87	276	295
5.	7.75	268	310
6.	9.75	264	312
7.	14.00	241	250

It is to be observed, that in the foregoing experiments the muscles in action were not allowed to *rest* during the whole time of work.

Linnean Society, Nov. 18.—Dr. G. J. Allman, F.R.S., president, in the chair.—The following paper was read:—On the organisation and systematic position of the Ornithosauria, Part I., by Prof. H. G. Seeley, F.L.S. The different results obtained by investigators who have written upon Pterodactyles, led the author to propose a method of research in Comparative Anatomy by which the true nature of these animals could be determined. It consists chiefly in an attempt to distinguish between the characters which make animals members of a class of Vertebrata, and the characters which make those animals members of vertebrate ordinal groups. The class characters were regarded as furnished by the soft vital organs, while the ordinal characters are derived from the skeleton. This was illustrated by an argument tending to show that since the form of brain,

* “Principles of Animal Mechanics” (London, 1873).